8.0 Statewide Freight Forecasting in Support of Regionwide Forecasting

8.1 Introduction

Both Kansas and Wisconsin are unusual in that they have statewide freight forecasting models. The goals of the two models differ considerably, but both are derivatives of the methods described in NCHRP Report 260.[1] Specifically, each of the two models:

- geographically organizes its data into zones, defined primarily as counties;
- identifies the amount of commodities shipped between any two zones;
- determines the fraction of each commodity that is carried by trucks;
- estimates the number of trucks required to carry the commodity; and
- assigns the trucks to a highway network to obtain truck traffic volumes.

The principal desired outputs of both models are estimates of freight vehicle volumes on various transportation facilities. However, the models differ considerably in their use of data and the organization of the steps. A good statewide forecast can provide to the region future estimates of external-to-external traffic and external-to-internal traffic on those highways with the greatest amount of truck traffic.

Degree of Trust. A statewide model may not be intended for applications within a region. When using a statewide model for regional purposes, it is important to first determine whether the statewide model has a sufficiently detailed zone system, has incorporated a good cross-section of commodities and modes, and has been well calibrated. The degree of trust can usually be ascertained by comparing the base-year forecast to known truck volumes. When the match is consistently good throughout the State, results from the statewide model may be fully and confidently used in a regional forecast. Otherwise, the results of the statewide model should only be used in conjunction with data of known validity, such as base-year truck volume counts.

[1] Frederick W. Memmott, *Application Of Statewide Freight Demand Forecasting Techniques*, National Cooperative Highway Research Program Report 260, National Research Council. Washington D.C. 1983.

■ 8.2 The Interface at External Stations

A statewide model interfaces with the regional model at its external stations. Ideally, the following two conditions should hold true:

> **Condition 1.** Flows to and from each external station should be consistent with the forecasted volumes on the corresponding highways in the statewide network; and
>
> **Condition 2.** Through trips between two external stations should be consistent with number of trucks using both corresponding highways on the statewide network.

These conditions should hold for the base-year forecast and for any future-year forecasts. The first condition can almost always be satisfied by proper settings for external station data. However, the second condition requires the construction of an external-to-external trip table, which can be a hit-and-miss proposition even under the best of circumstances. The building of an external-to-external trip table can be facilitated when the statewide model has the capability of providing information about the amount of traffic that occurs between many pairs of links or when the statewide model has special capability of creating a trip table for a "window" on the network.

For statewide models that do not have these special capabilities, it is still possible to develop the necessary external station information for the regional model. For any link on the statewide model near a regional external station, it is essential to categorize the amount of traffic that is:

- External-to-Internal (E-I);
- Internal-to-External (I-E);
- Internal-to-Internal (I-I); and
- External-to-External (E-E).

Most cities are represented by very few centroids on the statewide network. Thus, the amount of regional I-E or E-I traffic may be readily identified by performing either a select link analysis or a select zone analysis on the statewide network. When the region is represented by more than one centroid, I-I traffic may be found by:

- inspecting the origin-destination table;
- performing a select zone analysis; or
- ignoring it altogether.

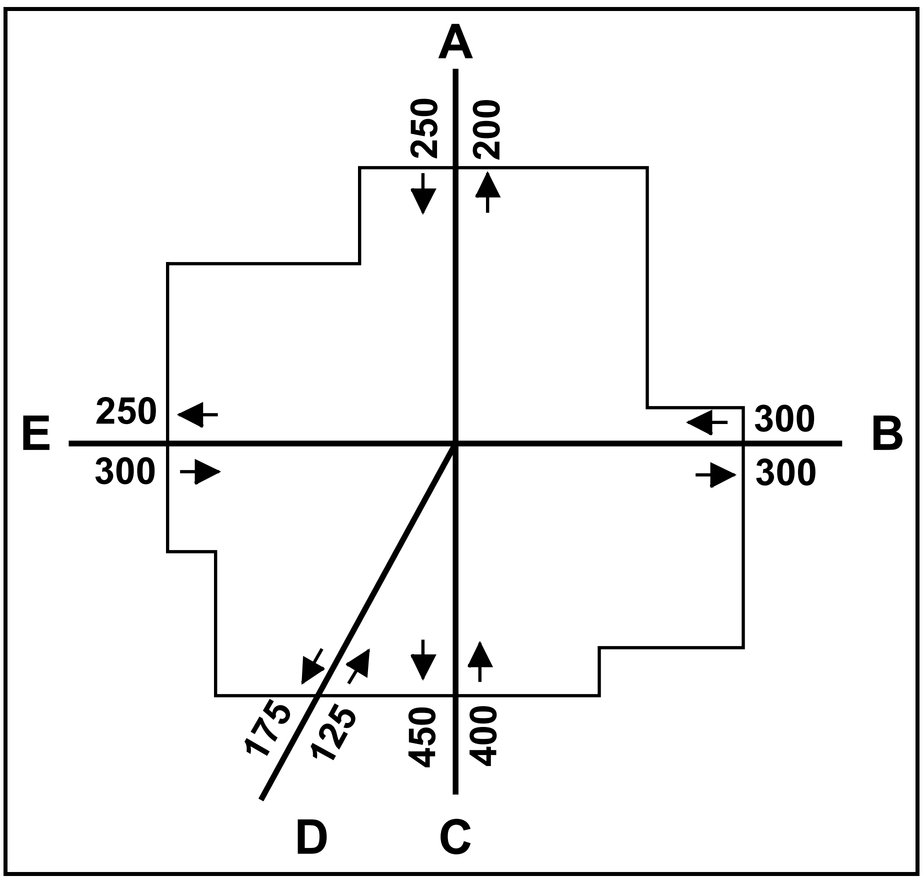
In a region represented by a single centroid, internal-to-internal traffic must always be ignored, as it would not have been assigned to the network. The remaining traffic (after accounting for E-I, I-E and I-I trips) is E-E.

Once the amount of E-E traffic on each link has been identified, it is possible to synthesize an E-E trip table. When doing so it is important to understand that there is a considerable amount of error in the link volumes coming from the statewide model, and this error *increases* as the link data are further disaggregated into a trip table. An increase in error would be expected because of the additional assumptions required to split incoming traffic into its various outgoing flows. However, a high degree of precision is not always necessary for forecasting. Consequently, a reasonably good E-E trip table can be created by following these steps:

Step 1. Obtain a drawing of the regional network, showing its external stations. Obtain a map of the region that includes neighboring cities, major generators in close proximity to the region, and barriers to travel (e.g., rivers and mountains).

Figure 8.1 below shows a small hypothetical city, Daneville, with five external stations.

Figure 8.1 Daneville External Stations



Step 2. List all pairs of external stations that are unlikely to share trips. Examples are: (a) pairs of external stations on paths leading from the region to the same

neighboring city; (b) pairs of external stations on two sides of the same divided highway; and (c) pairs of external stations where both are on paths leading to rural or suburban locations. In the Daneville example, the external stations C and D lead to the same part of the State, so they will not exchange trips.

Step 3. Create a matrix of weights, one weight for each pair of external stations. Set the weight to 0 for all elements on the diagonal of the matrix and for all pairs of external stations identified in Step 2. Set the remaining weights to 1.0. In general, the resulting matrix should be symmetrical.

Table 8.1 shows Daneville's matrix of weights.

Table 8.1 Initial Daneville Matrix of Weights

		Destination				
		A	**B**	**C**	**D**	**E**
	A	0	1	1	1	1
	B	1	0	1	1	1
Origin	**C**	1	1	0	0	1
	D	1	1	0	0	1
	E	1	1	1	1	0

Step 4. Apportion trip origins across destinations according to the total trips at each destination multiplied by the weight from Step 3.

Table 8.2 shows the weighted destinations, and Table 8.3 shows Daneville's E-E trip table. At this point the column totals will probably not agree with the needed destination totals.

Table 8.2 Daneville Weighted Destination Trips

		Destination					
		A	**B**	**C**	**D**	**E**	**Sum**
	A	0	300	450	175	250	1175
	B	200	0	450	175	250	1075
Origin	**C**	200	300	0	0	250	750
	D	200	300	0	0	250	750
	E	200	300	450	175	0	1125

Table 8.3 Initial Daneville External-to-External Trips

		Destination					
		A	B	C	D	E	Sum
	A	0	64	96	37	53	250
	B	56	0	125	49	70	300
Origin	C	107	160	0	0	133	400
	D	33	50	0	0	42	125
	E	53	80	120	47	0	300
	Sum	249	354	341	133	298	

For example Cell AC is calculated as 250*450/1175 = 96.

Step 5. Check the column sums of the E-E trip table for consistency with the number of destinations. If necessary, adjust the weights in Step 3 by multiplying them by the desired destination total and dividing them by the total obtained in Step 5. Redo Step 4 and perform another check (and adjustment, if necessary). Continue this process of adjustments until the column totals are within 1% to 2% of the needed destination totals. The first round of revisions are shown in Table 8.4 and Table 8.5. Notice that the destination totals in Table 8.5 are closer to the desired values, but they are not yet acceptable.

Table 8.4 Revised Daneville Matrix of Weights

		Destination				
		A	B	C	D	E
	A	0	0.85	1.32	1.32	0.84
	B	0.8	0	1.32	1.32	0.84
Origin	C	0.8	0.85	0	0	0.84
	D	0.8	0.85	0	0	0.84
	E	0.8	0.85	1.32	1.32	0

		Destination					
		A	**B**	**C**	**D**	**E**	**Sum**
	A	0	49	115	45	41	250
	B	40	0	149	58	53	300
Origin	**C**	102	163	0	0	134	399
	D	32	51	0	0	42	125
	E	39	62	144	56	0	301
	Sum	213	325	408	159	270	

Table 8.5 Revised Daneville External-to-External Trips

Step 6. Check the trip table for reasonableness. Change any weights that are causing unreasonable results, then repeat Steps 3 to 5. Document the logic underlying any adjustment.

It should be noted that this procedure is very similar to a doubly-constrained gravity model, except that weights are used instead of friction factors.

Presumably, this procedure could be performed individually for each of the three categories of trucks given a sufficiently robust statewide forecasting model. More likely the E-E trip table will contain a combination of all three truck categories.

These steps should only be performed if the statewide results can at least be trusted at the link level. If not, the statewide model can still be used to establish trendlines.

Validation for Reasonableness. Planners should be comfortable about the accuracy of the truck E-E trip table before it is incorporated into a forecast. Three questions must be answered, namely:

1. Are the link volumes from the statewide model sufficiently accurate?

2. Is the disaggregation process for building a truck E-E trip table yielding sufficiently accurate estimates of trips between external stations?

3. Are the flows in the truck E-E trip table plausible?

In the absence of an existing truck E-E trip table, these questions cannot be answered with a great deal of confidence. Instead, the E-E trip table should satisfy subjective tests of reasonableness, supplemented by whatever data are readily available. Data that can indicate a problem with the truck E-E trip table include:

- an old truck E-E trip table;
- a partial truck E-E trip table;
- a passenger vehicle E-E trip table;
- truck counts on ramps at interchanges of freeways and other major arterials leading to external stations; and
- interviews with shippers, carriers, state police, or state DOT officials.

Although such data may not be sufficient to build a base-year truck E-E trip table, it may be possible to use them in validating a trip table built by other means.

8.2.1 Statewide Trendlines at External Stations

Even when the statewide model cannot be trusted at the link level, it may be still be trusted to give a good approximation for the growth in truck traffic near the region (see Chapter 3). A single estimate of truck traffic growth may be made for all external stations in the region, or estimates can be made for groups of adjacent external stations. Once obtained, these estimates of growth can be used to convert base-year external station data into appropriate settings for future-year forecasts.

8.3 Kansas Statewide Agricultural Commodity Model

The Kansas DOT (KDOT) has been involved with freight forecasting since 1984, when a new computerized state highway network was established. In this initial effort, they used population, employment and agricultural sales to generate truck trips. Upon using this methodology, it was found that there was a need for a better commodity and heavy truck forecasting model. In 1992, they undertook a new freight forecasting model dealing with truck movement.[2] This was still an exploratory model, and it was limited to the movement of five commodities (e.g., corn, wheat, sorghum, soybeans and boxed beef). These commodities were chosen because the State had collected detailed data for these commodities for intrastate and interstate movement by mode. The main purpose of this second effort is to examine the assignment of truck trips from commodity flows. There

[2] Eugene R. Russell, L. Orlo Sorenson, and Rick Miller, *Microcomputer Transportation Planning Models Used To Develop Key Highway Commodity Flows and To Estimate E.S.A.L. Values*, Department of Civil Engineering, Kansas State University, September, 1992.

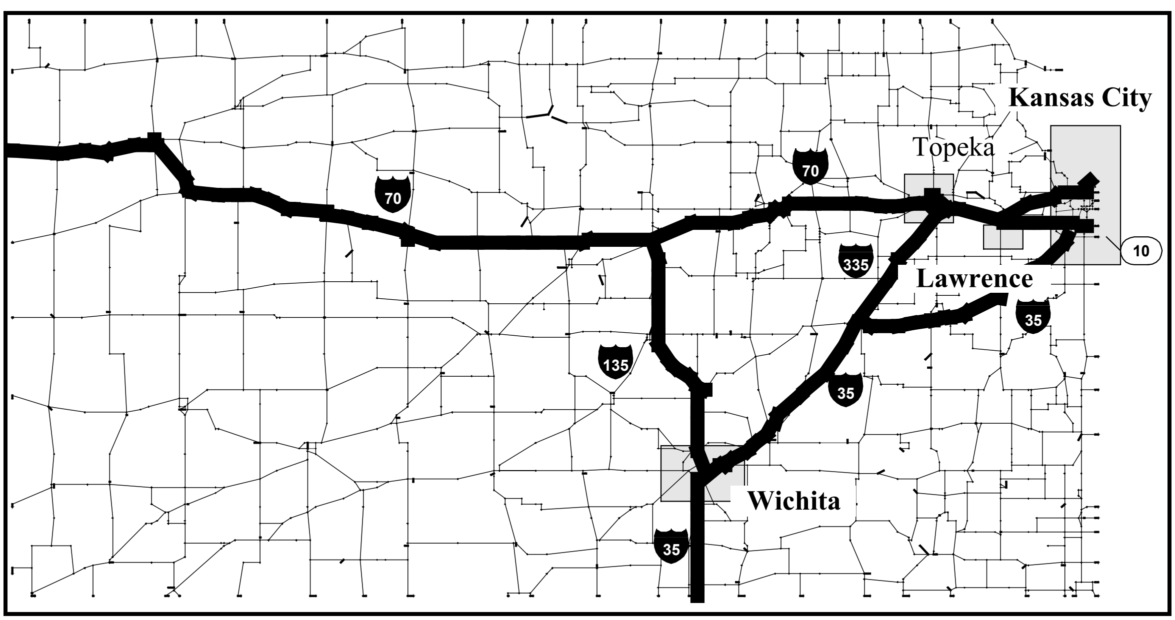
was some attempt to model non-agricultural truck movement, but this was not the main focus.

8.3.1 Elements of the Model

The development of this model consisted of five steps, namely: (1) network development; (2) data assembly and analysis; (3) trip distribution; (4) conversion of commodity flows into truck flows; and (5) trip assignment.

Step 1 - Network Development. Three separate networks were used, differing only in the way link impedances were determined: a speed network; a terrain network; and a toll facility network. The networks included 202 TAZ's and 2,200 links. Zones of interest here included 105 counties and 69 external stations. For zones corresponding to counties, the location of the county seat became the zone centroid. External stations were located where state highways cross the Kansas border and where KDOT had recent counts of total heavy trucks. The networks were derived from a network originally drawn for KDOT's UTPS mainframe model; that network was downloaded to a microcomputer for subsequent processing. The complete network is illustrated in Figure 8.2 with the freeways shown as wider lines.

Figure 8.2 Network for the Kansas Statewide Freight Model Highlighting Interstate Highways



Step 2 - Data Assembly and Analysis. The model utilized secondary data collected by the State of Kansas concerning movements of five commodities identified. It also used origin and destination data collected at monitoring stations at the border and at other key locations throughout the state. This data were supplemented by the use of mail surveys, telephone reports and personal on-site interviews. The state data also included the movement by modes (truck, rail, and barge) so that there was no need to use other sources, formulas or broad assumptions to derive the modal split for the commodity flows.

Step 3 - Trip Distribution. Three types of trip tables were created for the following movements: internal-to-internal; external-to-external; and internal-to-external. The internal-to-internal trip table was synthesized from the commodity flow data. The external-to-external trip table was developed from O-D studies at various locations around the state. The internal-to-external and external-to-internal trip tables were calculated by a gravity model.

Step 4 - Conversion of Commodity Flows into Truck Flows. Modal splits by commodity were based on actual historical flow data from producer to transfer point or processing point. Also available were flow data concerning truck movement from grain elevators to users. Truck flows were obtained from commodity flows by assuming that all trucks carried a single commodity and were equally loaded. Trucks were assumed to carry 40,000 of boxed beef or 850 bushels for grain commodities. However, the developers of the model later reasoned that 910 bushels per load for grains and 44,000 per load of boxed beef would have produced better estimates of equivalent truck loads.

Step 5 - Traffic Assignments. All-or-nothing traffic assignments were done for each of the five commodities on each of the three networks. The results by commodity by network were totaled to yield three networks that contained the sum of the loadings. To obtain a composite network, percentages were weighted 50, 30 and 20 percent, respectively. This method of creating a multipath assignment obviated the need for either estimates of passenger traffic or link capacity. The assigned volumes are illustrated in Figure 8.3. The results were judged to be smooth and realistic.

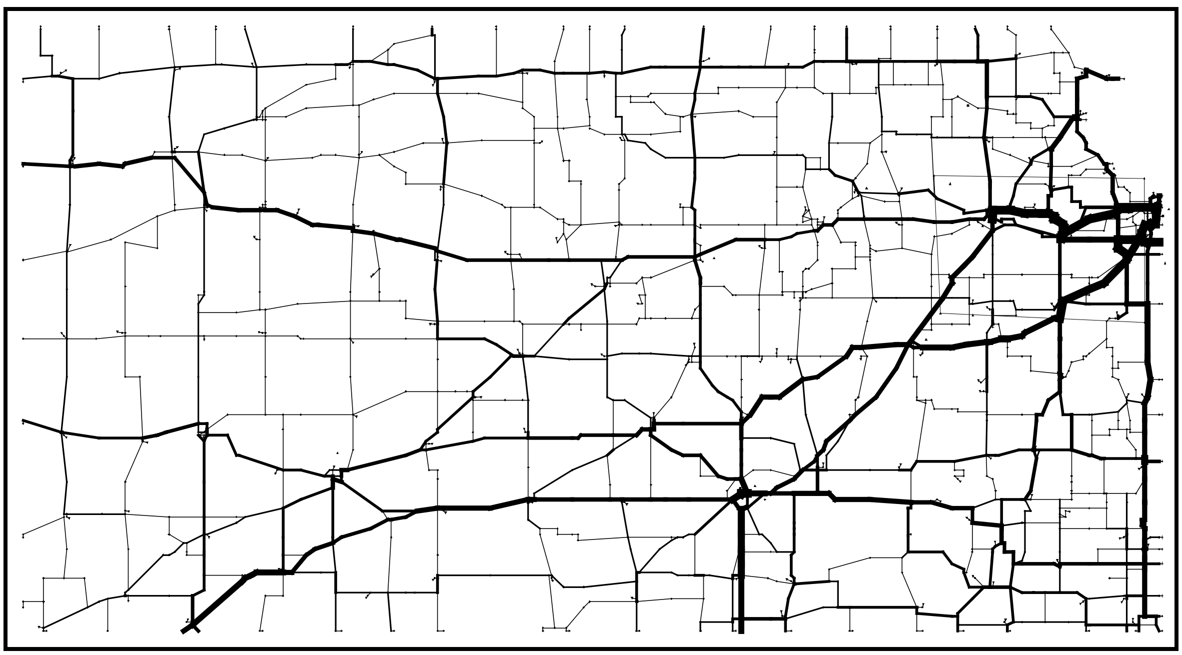
8.3.2 Weaknesses Recognized by Kansas DOT

Weaknesses recognized by KDOT include insufficient validation, assumptions about truck payload, imprecise means of determining good impedance measures, the judgmental method of weighting the results from the three networks, and an inability to precisely calibrate the gravity model for internal-to-external and external-to-internal trips. Many of these problems could have been overcome had KDOT been able to obtain a comprehensive set of reliable truck volume counts and perform a rigorous calibration. Another major problem relates to omitted commodities, both agricultural and nonagricultural. KDOT is continuing its efforts in statewide freight modeling, so better forecasts should be available in the future.

8.3.3 Overall Assessment of KDOT's Freight Model for Regionwide Forecasting

At present the usefulness of KDOT's model is limited to establishing trendlines and growth factors (see earlier section and Chapter 3). Without extensive network calibration, the model cannot reliably forecast volumes on highways leading in and out of many urban areas. However, the amount of growth in freight traffic near and through urban areas should be well predicted. Potentially and with KDOT's intended refinements, the model could permit a nearly seamless integration of statewide and regional freight forecasts.

Figure 8.3 Forecasted Truck Volumes by the Kansas Statewide Model



Note: The widths of the links are proportional to the assigned truck volumes.

8.4 Wisconsin Intermodal Freight Model

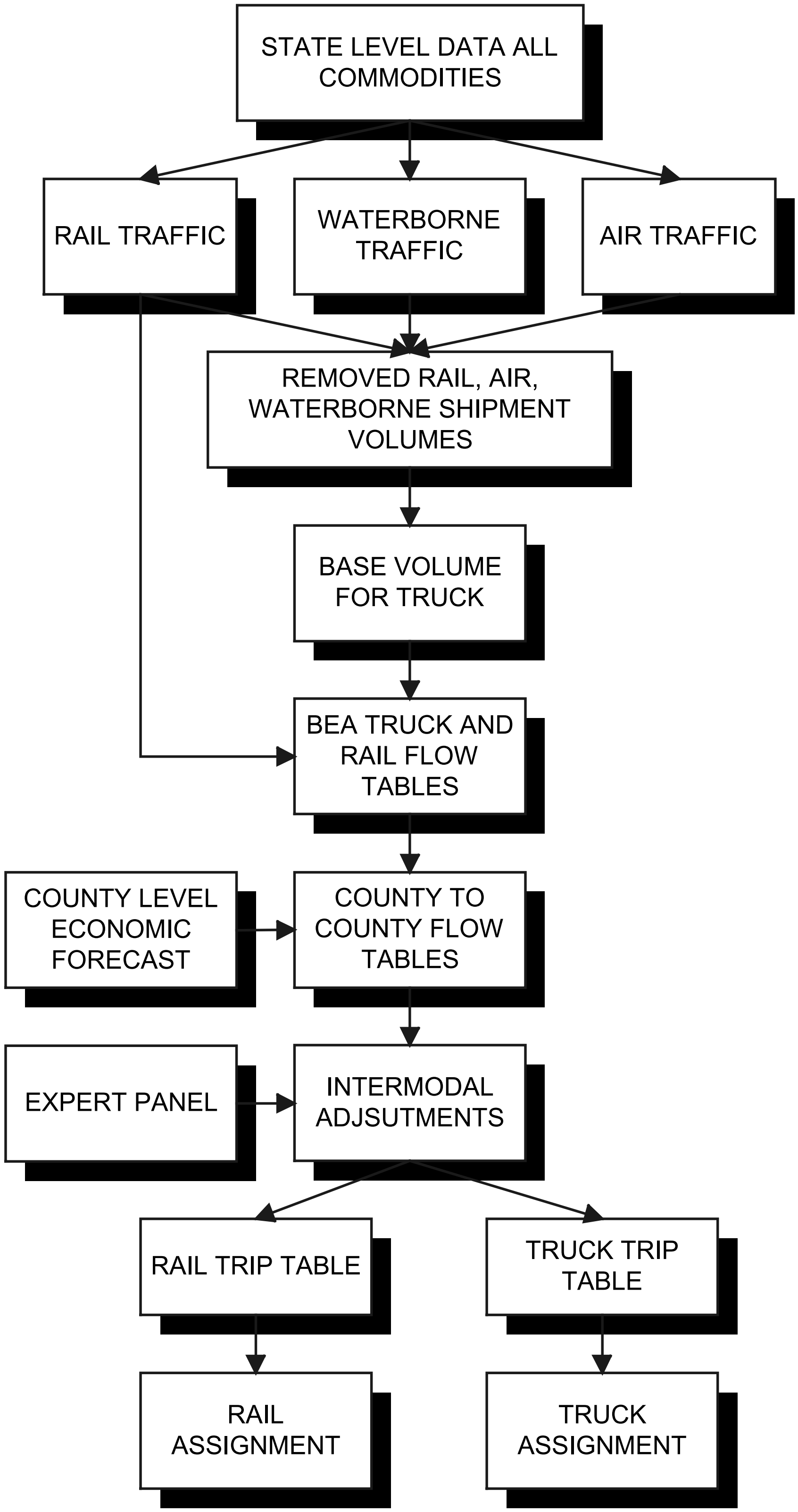
8.4.1 Overview

The Wisconsin Department of Transportation (WisDOT) undertook freight forecasting as part of its long-range multimodal plan -- Translinks 21.[3] WisDOT's goals included the construction of a database of forecasted commodity flows and the creation of the ability to ascertain forecasted link volumes for all major freight modes in the state. The process of forecasting truck volumes, in particular, is illustrated in Figure 8.4. WisDOT's forecasting method provides a good example of how data can be collected from both primary and secondary sources and then used effectively to arrive at a statewide truck traffic forecast.

WisDOT's effort involved the development and analyses of integrated sets of passenger and freight data for all intercity modes. County level commodity flow data for all modes was developed. The commodity flow data were converted to tonnages and vehicles to arrive at the traffic flow by mode. These were then assigned to their respective networks.

Figure 8.4 Overview of the Truck Component of Wisconsin's Freight Forecasting Model

[3] Wisconsin Department of Transportation, *Translinks 21 Technical Report Series: Multimodal Freight Forecasts for Wisconsin*, Draft No. 2, 1995.



The flow diagram of Figure 8.4 provides an overview of the various processes and interlinkages in the preparation of the freight movement data.

8.4.2 Building the Commodity Flow Data Set

The original database for WisDOT's multimodal plan was *Transearch* -- a proprietary database of US freight movements produced by Reebie Associates. Transearch includes descriptions of freight traffic shipments for various geographic markets, commodities, units of measures, and seven modes of transportation. The following are the four stages of Transearch data construction, as applied in Wisconsin:

> **Stage 1.** Establishment of the level and sources of production and consumption of all goods, using industrial output by state and sector, population and industry employment by county, and foreign trade.
>
> **Stage 2.** Determination of the level of railroads, water, air and pipeline traffic from commercial and industrial sources. The geographic units are all converted to BEA regions.
>
> **Stage 3.** Establishment of the level of truck flows by subtracting the known modal traffic developed in Stage 2 from the total production developed in Stage 1. The truck flows are checked against industry statistics and state flows using various trucking data sources.
>
> **Stage 4.** Disaggregation of the truck flows to county-to-county flows using county factors and inter-industrial trade patterns.

WisDOT supplemented the Transearch database with new data to make it specific to Wisconsin. These were referred to as the custom inputs, which fall into four categories:

1. population and employment data by county and industry;

2. industrial activity for the energy, agriculture and dairy, forest and paper, aggregates and mineral sectors;

3. waste generation and consumption; and

4. exports.

A mode by mode update of the 1991 Transearch data to 1992 levels was undertaken by WisDOT. Relevant indices, output measures and projections were used for updating. Volumes for certain commodities were adjusted according to the industrial output within Wisconsin. Overhead volumes (i.e., flows going through Wisconsin without originating or terminating inside the state boundary) were also included in the database.

The railroad traffic was taken from 1992 ICC Private Use Waybill Sample, which provided the commodity tonnage information for rail traffic originating and terminating in and around Wisconsin. Likewise, waterborne and airborne freight traffic data pertaining to the State of Wisconsin were generated. Truck traffic, aggregated to BEA regions in the Transearch database, was further broken down to the county level for local area analysis. Truck volumes of secondary shipments (shipments outbound from distribution centers, i.e., wholesalers or intermodal terminals) and many non-manufacturing goods were not included in Transearch. Volumes were generated based on the county level data for wholesaling and warehousing employment, industrial activity, and waste generation and consumption. In this way a unified structure of freight OD flows by different modes was developed for 1992 base year.

8.4.3 Freight Forecast

Base-year 1992 data were used to develop forecasts for year 2020 and for five intermediate target years. Industrial employment and productivity were used for the freight forecast. The trendline logic applied consisted of: (a) a change in employment due to a change in production yields a similar change in output, (b) output results in shipments, and (c) commodities can be related to output of a particular industry through SIC codes.

A projection of the employment was prepared for each year between 1992 and 2020 by using economic indicators of 92 separate classes of industry, equivalent to two digit SIC codes. Employment was calibrated to the official population projection of the State of Wisconsin, embracing all forms of economic activities. This forecast was made for each of the 106 counties, constituting the set of local analysis zones. The employment forecast for the remainder of the country was taken from the Regional Projection of the BEA. Information regarding productivity in Wisconsin was provided to WisDOT by *REMI* (*Regional Economic Models Inc.*) -- a firm specializing in regional economic projections. Factors showing change in output per employee by industry group over time were developed, which were used as a multiplier to enlarge or dampen the effect of employment change on output.

Finally, the base-year freight forecast of flows was generated. Beginning with the 1992 base-year volumes by commodity and origin, tonnage was multiplied with the combined ratio of change for employment and productivity to that origin and relevant industry. This was done for each target year assuming the same rate of change for all modes carrying a given commodity from a single origin. Adjustments in the primary freight forecast were made for certain commodities (e.g., farm outputs, fuels, waste, nonmetallic minerals) and for export and air forecasts, which were judged to grow either faster or slower than the average for all freight.

Trendlining Issues. The freight forecast was developed with econometric factors that were derived from long-term trends. Any deviations from these trends signify the varying effects by industry and locality, which result in variations in volume for freight carriers. Such deviations can affect the overall share of traffic attributed to each mode, but there is not a true modal shift as a consequence of shipper choice.

8.4.4 Intermodal Adjustments

WisDOT also needed both long-term and short-term estimates of intermodal potential (as a percentage of total flow) by commodity. They prepared these estimates primarily by referencing the commodity flow information derived from the aforementioned freight traffic database and separate results from a survey of shippers and operators conducted by WisDOT in 1994.

One of the WisDOT's future scenarios, the truck-rail scenario, is based on the state and national trends of:

- significant national growth in intermodal activity and partnerships between major trucking and railroads companies;
- increase in highway congestion;
- long-haul driver shortages; and
- development of intermodal technologies and equipment leading to increased efficiency.

The intermodal potentials for the selected commodities, i.e., the commodities being transported by trucks, were identified in the shippers' and the operators' survey. The commodities were subjectively classified into four categories based on their intermodal potential. The survey also established break points for distances at which intermodal transport was likely to be more attractive than truck-only transport. Strong preferences were shown for 500-mile thresholds, which were adopted as the minimum distance for intermodal freight movements in subsequent analysis. Frequency of shipment was identified as the principal service component necessary to meet the requirement of shippers to convert to intermodal.

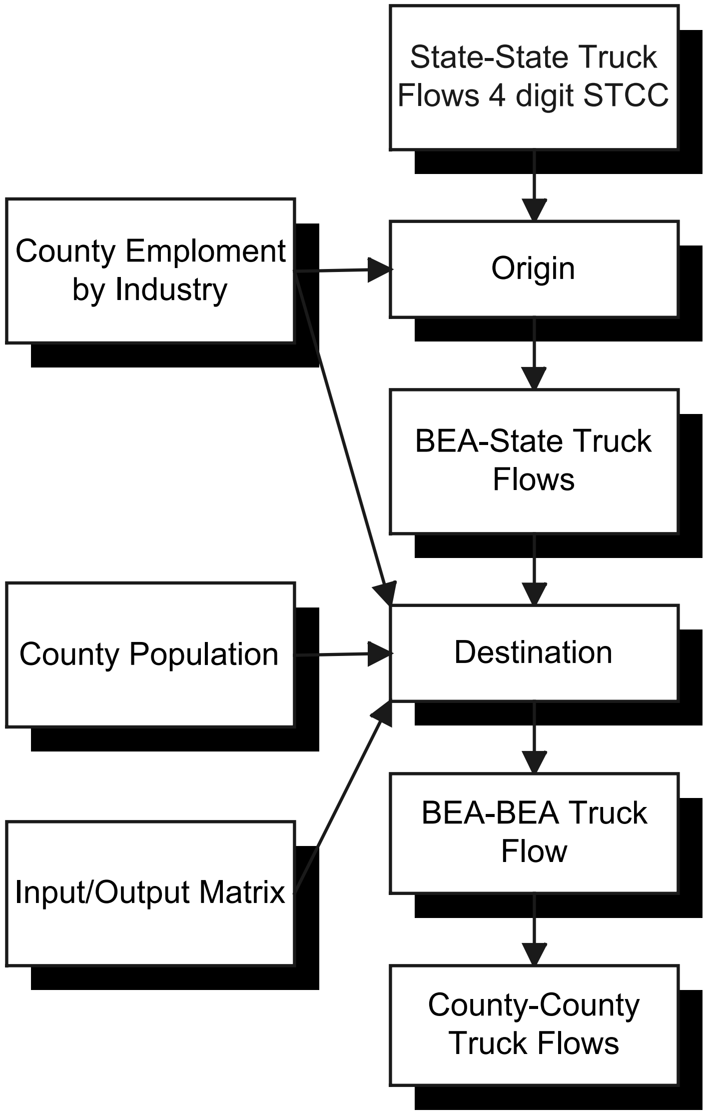
After the intermodal flows were identified, rail and truck trip tables were appropriately adjusted and assigned to railroad and highway networks. To amplify the procedure for truck forecasting, the following section provides a review of the process of truck trip generation and truck assignments.

8.4.5 Determination of Truck Traffic

As indicated in Figure 8.4, the amount of truck traffic was determined by subtracting shipment flows by competing modes from the total production and consumption of goods. The truck flows so generated were checked against trucking industry statistics and information about state-to-state flows. The truck shipments of manufactured goods were found to be about half of the tonnage.

The State-to-State truck flows were disassembled to the county level via BEA regions (see Figure 8.5) .

Figure 8.5 State-County Disaggregation Process



The four-step disaggregation process was as follows:

Step 1. Traffic volume by 4-digit commodity code was considered for each O-D flow.

Step 2. At the origin, the industry producing the commodity was identified by industrial codes and located by county. The origin volume was allocated to each county based on its share of employment in the eligible industry.

Step 3. The consumers of the commodity at the destinations were a mixed group, consisting of industry and the general public. The patterns of consumption were determined by an Input-Output table. For any given commodity the O-I matrix indicates the relative amount consumed by each industry or economic sector.

Step 4. Based on the share of population for the general public and employment for industry, the destination volume was distributed to each county.

Hence, the O-D flows for BEA regions were disassembled to the county level by using population and employment data.

The truck trip matrix was developed by converting the annual commodity tonnage to annual truckloads by using typical commodity weights per truck for each commodity. The densities of the commodities on trucks were taken from the densities generated for the rail database.

The densities were applied to truckloads using 24 tons as a maximum payload for a tractor-trailer rig. Finally, annual truckloads were divided by 312 (6 days per week multiplied by 52 weeks) to obtain daily truck loads. The resulting trip matrix was assigned to the highway network using an UTPS-style software package. A stochastic multipath assignment method, which allows all efficient paths between zone pairs to be considered likely, was used. A calibration process was then undertaken to replicate base year (1992) truck volumes on the highway network.

8.4.6 Observations about the Wisconsin Statewide Model

WisDOT's approach to freight forecasting is more ambitious than KDOT's, although its success is also heavily dependent upon achieving a good calibration to base-year truck counts. Perhaps the greatest concerns with WisDOT's methodology are possible errors associated with the process of elimination to arrive at the truck flows. In spite of all the extra effort, WisDOT's model, like KDOT's, is limited for regionwide forecasting by the use of counties for zones. Consequently, the model cannot readily provide information on intra-regional truck movements.

Notwithstanding the above concerns, WisDOT's efforts illustrate the potential of freight forecasting and can provide solid information for calibrating and forecasting external stations in regional truck networks.

■ 8.5 Use of Intermodal Management Systems

8.5.1 IMS Possibilities

There is great potential in the development of State intermodal management systems (IMS) for expanding the scope of traffic forecasting. Traditional transportation planning has paid limited attention to intermodal transportation, particularly the freight component. IMS's promise to provide for the development of an ongoing intermodal and multimodal database, which can integrate both statewide and regional information for more comprehensive travel forecasts.

The foundation of an IMS is the development of an ongoing database and a geographical information system (GIS) for spatially-referenced data. Some of the database items that could be included in an IMS are: commodity flows statewide by mode and by network; intermodal network and facility characteristics (i.e. types of runways at airports, number of cranes at ports, geometrics at key intersections and interchanges of highways, ease of transfer between intracity/intercity public transportation); long range freight forecasts; and modal counts (i.e., truck type by facility). These database items could be shared between state and regional agencies to provide the basis for short and long term intermodal plans, including regional forecasts. With the development of wide-area and local-area computer networks, and the affordability of appropriate hardware and software, a shared database should be a realistic goal.

Many States have made plans for the development of an IMS. However, the scope and detail for the various IMS's vary greatly, as does their applicability to freight forecasting. This is not surprising given the newness of this planning tool. The State IMS plans described in the next section have forecasting elements or databases that could be readily integrated into regional forecasting. The other State IMS plans have not been developed sufficiently to ascertain whether they contained these components.

8.5.2 Review of Selected State IMS Plans

California Intermodal Transportation Management System

The California Department of Transportation (Caltrans) is planning a comprehensive IMS that utilizes a statewide database.[4] Caltrans has completed the collection of a portion of its proposed IMS database including an inventory of intermodal facilities. It plans to collect data on freight and person movement, geometrics, and data elements for all modes, among other data. Future database collection will be determined according to developed performance standards.

This database will use a commercial database management system in conjunction with a geographical information system (GIS). The primary computer system will be a local-area network using client-server software. In addition, the data will be available to Caltrans' district offices by CD-ROM. The database will have a flexible architecture that will allow regional and local planners to integrate their plans and modeling efforts with the State IMS. There are also plans to incorporate expert systems and artificial intelligence components into the database programs to make the IMS more powerful.

As part of this IMS the freight demand will be estimated for 10-, 20-, and 30-year time periods. Freight data will be provided by Reebie Associates based on an econometric model and long-haul truck data obtained through a data exchange program. Training for

[4] California Department of Transportation, *California Intermodal Transportation Management System Work Plan - Preliminary Draft*, July, 1994.

Caltrans employees and regional planners on the use of computer applications will be provided.

Idaho Intermodal Management System Work Plan

The Idaho IMS Plan[5] includes an inventory and collection of modal traffic flow data. Idaho has divided its data needs into supply and demand categories. Some of the data to be collected on the supply side are: facility location; modes served; hours and frequency of service; capacity; flow rates of persons and goods; industries served; and storage and consolidation capabilities. On the demand side the following information is to be collected: freight characteristics relevant to movement such as density, containerization requirements/opportunities, hazardous qualities; goods and freight vehicle flows on links and through junctions, including intermodal facilities by time and day; origin and destination matrices of person movements and passenger vehicle movements by purpose and with diurnal characteristics; and origin and destination matrices of freight, stratified by type of commodity and characteristics relevant to modal elements of path.

The database structure is proposed to be compatible with several management systems. The database will be used in combination with other plans and performance standards to access short- and long-term needs and projects. One of the components will be the capability of using the database to develop intermodal forecasts.

Michigan Transportation Management System

MDOT's IMS Plan[6] includes an extensive existing database. MDOT is finishing the development of a GIS for all highway systems. Data still to be collected include: origins and destinations, along with access to non-highway facilities; goods movement; and vehicle classification.

The database and GIS will be integrated so that there is an interrelationship between MDOT's overall management plan for transportation facilities, such as bridge management, congestion management and intermodal management.

Nevada Intermodal Assessment System

Nevada proposes a comprehensive, spatially referenced IMS utilizing a GIS containing numerous items related to freight movement.[7] Spatially-referenced data that have been

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[5] Idaho Department of Transportation. *Idaho Intermodal Management System Work Plan*, November, 1994.

[6] Michigan Department of Transportation, *Intermodal Surface Transportation Efficiency Act: Transportation System Management Work Plan Overview*, September, 1994.

[7] Nevada Department of Transportation, *Nevada Intermodal Assessment System: System Description and Variable Documentation*, Planning Division, July, 1994.

collected include: description of highway links by a variety of attributes (such as type of facility), truck or truck restricted routes, number of lanes, commodity flow indicators; railroad links by several attributes (such as type of service and Federal rail classification); bridge inventory, including deck condition and annual average daily traffic volume; a description of airport facilities, including runway length, ownership, and enplanements.

The GIS for the IMS utilizes *TIGER* (*Topologically Integrated Geographic Encoding and Referencing*) point and line files for railroads, highways and airports. Thus, the GIS was created with minimal new data collection. The structure of the GIS enables data to be easily exported to a diverse set of software packages.

8.5.3 Discussion and Recommended IMS Elements

The range of detail and focus vary widely among States' IMS's. Some States perceive the IMS as only a short term management plan, while others perceive it as a vehicle for both long and short range intermodal planning, including freight forecasting. Still other States provide extensive detail about the establishment and use of their databases and GIS's, but were unspecific about the nature of the data itself.

Among all the plans reviewed, the previously discussed plans touched on elements of a well-constructed IMS. However, none had all of the elements. The following is a short recipe for an IMS that supports the needs of freight forecasting:

1. **Goals/Objectives and Performance Standards.** There should be a clear and distinctive delineation of goals and objectives and how these will be operationalized (i.e., responsibilities of the different actors, databases, hardware and software, implementation, and training schedule).

2. **Description of Database Items.** Existing and future database items should be selected on the basis of data availability, or on the basis of ease in collecting the data. These should be listed in the IMS plan for review by all involved agencies, including MPO's and other planning organizations. Data relevant to freight forecasting should be included within the database. Certain database items may be obtained conveniently, but they may be of limited applicability. Efforts to collect data items should be consistent with previously established goals.

3. **Database and GIS Structure.** Data should be transferable to a variety of planning organizations. The ease of transferability of data and geographic references between different software packages (existing and proposed) should be carefully planned and detailed before the implementation of the IMS. IMS plans should recognize the relationship of different agencies to the IMS in terms of whether they will be potential users of the GIS and/or database, their access to the GIS or database (i.e., local-area and wide-area computer networks), and their level of participation (i.e., updating of the database/GIS).

In conclusion, there was a wide disparity in the IMS plans. Many of the plans reviewed had elements that were extremely broad, overly ambitious, or difficult or clumsy to implement. However, there were other States that appear to be progressing such that their IMS will not be a bureaucratic exercise to satisfy federal requirements. This is a natural progression of events in the promulgation of new regulations. The next step would be for US DOT and their modal administrations (i.e., FHWA, FTA, FRA) to provide a better explanation of what an IMS should contain.

8.6 Discussion of Statewide Contributions

The case studies in this manual used statewide information to supplement local data where possible. Statewide traffic forecasts were especially helpful in setting external station data in future years. Truck traffic counts provided by the State DOT's were found to be reliable and essential for model calibration. States were also able to provide limited information on special generators, such as intermodal transfer facilities. A more comprehensive statewide database in the form of an IMS would have improved the responsiveness of the forecast and increased its accuracy. Data elements that could not be readily obtained but would have been useful include:

1. Truck counts by vehicle class on selected facilities;
2. Truck counts on a greater variety of facilities, including roads not designated as state trunk highways;
3. Lists of major truck trip generators, their commodity and employment characteristics, and their location;
4. Lists of truck routes or truck-restricted road segments;
5. A statewide, base-year truck forecast that is well calibrated to traffic counts on road segments serving as external stations for regional forecasting purposes;
6. Diurnal variation of truck trips by vehicle class and road functional class.

With this information, together with data already gathered for regionwide passenger travel forecasting, a truck forecast can be truly quick response.